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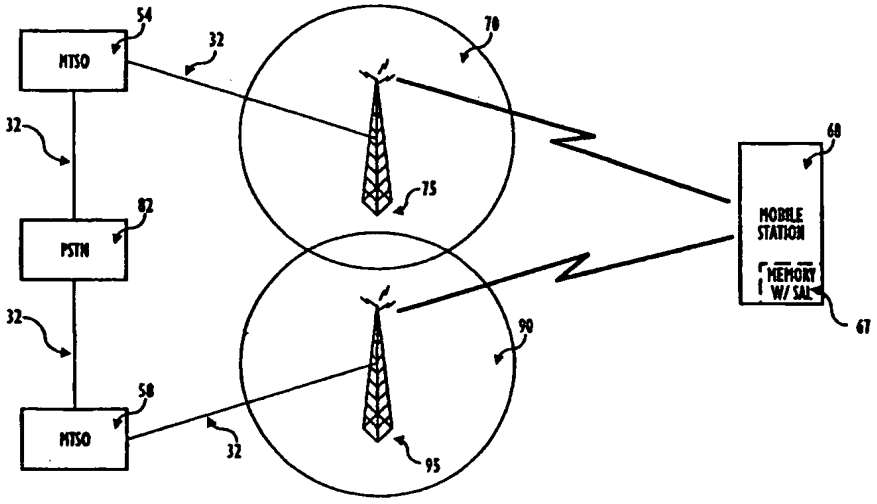


(57) Abstract

A mobile station (68) is provided with intelligent roaming capabilities. The mobile station, which may be implemented as a mobile, cellular, or PCS telephone unit, includes a System Access List (SAL) that is stored in a memory (67) of the mobile station (68). The SAL may be programmed into the mobile station through a physical interface (such as a computer interface) or by using an over–the–air programming function. When the mobile station (68) is initialized, the mobile station first scans the bands of its home system (54). A secondary band may also be provided for scanning, if the mobile station is unable to locate a control channel on its home band. If the mobile station is not located within its home system, the SAL is searched to determine whether the current system is a preferred system (58). The SAL may include information on the blocks of channels to scan in the preferred bands.

MOBILE STATION WITH INTELLIGENT ROAMING AND OVER-THE-AIR PROGRAMMING FEATURES

1. Field of the Invention

The present invention relates to the field of telecommunications. More particularly, the present invention relates to cellular or Personal Communications Services (PCS) network systems, and mobile stations having intelligent roaming and over-the-air programming features.

2. Acronyms

The written description provided herein contains acronyms which refer to, for example, various telecommunication services, components and techniques, as well as features relating to the present invention. Although some of these acronyms are known, use of these acronyms is not strictly standardized in the art. For purposes of the written description herein, acronyms will be defined as follows:

Advanced Mobile Phone Service (AMPS)

Analog Control Channel (ACC)

Base Station/Mobile Switching Center/Interworking Function (BMI)

Code Division Multiple Access (CDMA)

Complimentary Metal Oxide Semiconductor (CMOS)

Control Channel (CCh)

Customer Service Center (CSC)

Digital Control Channel (DCCH)

Digital Traffic Channel (DTC)

Electronically Erasable Programmable Read Only Memory (EEPROM)

Federal Communications Commission (FCC)

Group System for Mobile Communications (GSM)

Home Location Register (HLR)

International Mobile Station Identity (IMSI)

cell sites or base stations may be connected to Mobile Telephone Switching Offices (MTSOs) or Mobile Switching Centers (MSCs) through landlines or other communication links, and the MTSOs may, in turn, be connected via landlines to the Public Switched Telephone Network (PSTN).

Fig. 1 illustrates the basic components of a conventional cellular network. As shown in Fig. 1, a mobile station 38 may place or receive calls by communicating with a cell site 30 or a cell site 40, depending upon the geographic location of the mobile station and the cell coverage area that is provided by each cell site (i.e., cell coverage area 35 of cell site 30 or cell coverage area 45 of cell site 40). For purposes of illustration, mobile station 38 is depicted in Fig. 1 as being able to communicate with either cell site 30 or cell site 40, even though the mobile station is not illustrated as being located within cell coverage area 35 or cell coverage area 45. Under normal operating conditions, the extent to which mobile station 38 will be able to communicate with cell site 30 or cell site 40 will depend on the geographic location of the mobile station and the size of the cell coverage area of each cell site. Further, although only two cell sites are depicted in Fig. 1, the entire cellular network may include, for example, more than two cell sites. In addition, more than one cell site may be connected to each MTSO.

Mobile station 38 may include a conventional cellular telephone unit with a transceiver and antenna (not shown) to communicate by, for example, radio waves with cell sites 30 and 40. Various air-interface technologies may be implemented to facilitate communication between the mobile station and the cell sites. Cell sites 30 and 40 may both include a radio transceiver (not shown) and be connected by landlines 16 or other communication links to MTSOs 24 and 28. The PSTN 12 is also connected to each MTSO 24 and 28 by landline 16 or other communication links.

The MTSOs 24 and 28 may be conventional digital telephone exchanges that control the switching between PSTN 12 and the cell sites 30 and 40 to provide wireline-to-mobile, mobile-to-wireline and mobile-to-mobile call connectivity. The MTSOs 24 and 28 may also (i) process mobile station status data received from the cell site controllers; (ii) handle and switch calls between cells; (iii) process diagnostic information; and (iv) compile billing information. The transceiver (not shown) of each cell site 30 and 40 provides communications, such as voice and data, with mobile station

bit SID. In Europe, on the other hand, the Global System for Mobile Communications (GSM) standard (see, for example, Recommendation GSM 02.11, Service Accessibility, European Telecommunications Standards Institute, 1992) defines a process for network selection based on the mobile station reading the GSM equivalent of the SID, called the Public Land Mobile Network (PLMN) identity. The SID or equivalent system identification number is broadcast by each service provider or cellular provider and is used by the mobile station to determine whether or not the mobile station is operating in it's home network or if it is operating in a roaming condition. The mobile station makes this determination by reading the SID that is broadcasted in the cellular market in which it is located, and comparing it to the home SID stored in the NAM of the cellular phone unit. If the SIDs do not match, then the mobile station is roaming, and the mobile station must attempt to gain service through a non-home service provider. Due to the imposition of a fixed surcharge or higher per unit rate, the air time charges when the mobile station is roaming are customarily higher than when it is operating within its home network.

Operation under a roaming condition is often under the control of the mobile station user. The user can select whether the mobile station will operate in a Home System Only, A Band Only, B Band Only, A Band Preferred, or B Band Preferred operating mode. The user typically controls the system preference and mode operation through menu choice or selection. This current method of roaming control is conventionally known as "Preferred System Selection". In the most common roaming situation, the mobile station remains on the same band as the home cellular network. That is, if the mobile station is homed to a cellular network with an odd numbered SID (which is normally assigned to an A band cellular service provider), then the mobile station will obtain service from the A band cellular service provider when roaming.

Occasionally, the home service provider will program a mobile station with negative SIDs. Negative SIDs correspond to SIDs on which the mobile station should not obtain service. Negative SIDs may be used, for example, if roaming agreements are not in place between different cellular service providers. An example of a mobile station that utilizes negative SIDs is disclosed in BLAIR, U.S. Patent No. 4,916,728. As an alternative to negative SIDs, some mobile stations are programmed with positive or preferred SIDs. Positive or preferred SIDs are SIDs on which the mobile station should

SIDs, the mobile station will typically scan a plurality or all of the available frequency bands before determining the preferred carrier for a present service locality. It would be desirable to provide intelligent roaming capabilities for a mobile station to reduce the time and amount of scanning that is required by the mobile station when seeking a non-home network service provider. Prior systems do not provide, for example, sufficient intelligence in the mobile station to efficiently direct the mobile station to the particular band or bands where the mobile station may obtain service on a preferred system when it is roaming.

Further, there is a need to provide intelligent roaming capabilities for a mobile station which will not require any changes to present network interface standards (e.g. IS-41) or air interface standards (e.g., IS-136, IS-91A, IS-95), and which is independent of air interface technologies (e.g., Advanced Mobile Phone Service (AMPS), TDMA, CDMA, Personal Access Communication System (PACS) and PCS-1900 MHz). Such features are desirable in order to permit new intelligent roaming capabilities to be readily utilized by a mobile station and to allow seamless integration of such capabilities without modification to present industry standards. For more information on network interface standards such as Interim Standard 41 (IS-41), see, for example, TIA/EIA-IS-41.5-C, Cellular Radiotelecommunications Intersystem Operations: Signaling Protocols, Telecommunications Industry Association, February 1996. For more information on air-interface standards such as Interim Standards 95 and 136 (IS-95 and IS-136), see, for example, TIA/EIA-IS-95-A, Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular Systems, Telecommunications Industry Association, May 1995; TIA/EIA-IS-136.1-A, TDMA Cellular/PCS- Radio Interface-Mobile Station-Base Station Compatibility-Digital Control Channel, Telecommunications Industry Association, October 1996; TIA/EIA-IS-136.2-A, TDMA Cellular/PCS-Radio Interface-Mobile Station-Base Station Compatibility-Traffic Channels and FSK Control Channel, Telecommunications Industry Association, October 1996; and TIA/EIA/IS-136.1-A-1, Addendum No. 1 to TIA/EIA/IS-136.1-A, Telecommunications Industry Association, November 1996.

Another desirable feature is to provide over-the-air programming of a mobile station to permit reprogramming of the mobile station with new intelligent roaming

contain information for the mobile station to use in determining whether to display a roam icon or indicator, and what alphanumeric system name to display when operating in a given system.

Further, an object of the present invention is to provide a mobile station having over-the-air programming capabilities. According to an object of the invention, the over-the-air programming capabilities may allow a System Access List (SAL), containing intelligence for roaming, to be stored and updated in memory of a mobile station by interfacing with the mobile station over the air.

According to one embodiment of the present invention, a mobile station is provided with intelligent roaming capabilities. The mobile station, which may be implemented as a mobile, cellular or PCS telephone unit, includes a System Access List (SAL) that is stored in a memory of the mobile station. When the mobile station is initialized (e.g., when the mobile station is powered ON, changes systems or SID area, operates in a "No Service" condition, or an Intelligent Roaming mode (IR Mode) is selected), the mobile station first scans the band of its home system. If the mobile station determines that it is located in its home system (e.g., by analyzing the SID of the current system), the mobile station remains on that band and obtains service from the home system. If the mobile station cannot find a control channel on the home band, then it may scan a secondary band in which the mobile station is guaranteed to find a control channel.

If the mobile station finds a control channel on its home band (but not in its home system) or the secondary band, the SAL is searched to determine whether the current system is a preferred system. This may be performed by comparing the SID of the current system with the entries and information in the SAL. If the SAL indicates that the current system is a preferred system, then the mobile station obtains service on the current system. If the current system is not the preferred system, then the SAL indicates or directs the mobile station to the exact band or bands where a preferred system may be located for that area. The SAL may also indicate the air interface technology supported on each of the preferred bands to assist the mobile station in finding a system of a given technology type.

According to an aspect of the present invention, the SAL that is stored in the mobile station may include information on the blocks of channels to scan in the preferred

the SAL in a memory of the mobile station. In order to perform over-the-air programming, the SAL information may be transmitted as information elements that are made part of an Over-the-Air Activation Teleservice (OATS). Over-the-air programming may also be achieved by embedding the SAL information within a System Operator Code (SOC) Specific Request message defined for OATS.

In accordance with another aspect of the present invention, a process for selecting a preferred system within a communication network may be provided, wherein the process includes: scanning a home band to locate a control channel; obtaining, when the control channel is located, a system identification number corresponding to a current service area in which the mobile station is located; determining whether the home system is available based on the system identification number of the current service area; accessing, when the home system is not available, a system access list (SAL) stored in the mobile station, the SAL comprising a plurality of entries indicating a system identification number and a corresponding frequency band for each preferred system; comparing the system identification number of the current service area to the entries of the SAL to determine whether a preferred system exists for the current service area; and identifying, from the entry that corresponds to the system identification number of the current service area, a frequency band where the mobile station can locate a preferred system for the current service area.

The process for selecting a preferred system, according to the invention, may also include scanning, when a current frequency band in which the control channel is located does not correspond to an identified frequency band of the preferred system, the identified frequency band to obtain service on the preferred system for the current service area.

In addition, the process may include obtaining service on the current frequency band when the current frequency band corresponds to the identified frequency band of the preferred system for the current service area.

An intelligent roaming system is also provided, in accordance with an aspect of the invention, to enable a mobile station to select a preferred system within a communication network when a home system of the mobile station is not available. The intelligent roaming system may comprise: a system for accessing, when the home system

includes system for storing the SAL in a memory of the mobile station. The over-the-air programming system may further comprise a system for transmitting SAL information as information elements that are made part of an Over-the-Air Activation Teleservice (OATS). In addition, the over-the-air programming system may further comprise a system for embedding SAL information within a System Operator Code (SOC) Specific Request message defined for OATS.

According to yet another aspect of the invention, a system is provided for selecting a preferred system within a communication network when a home system is not available to a mobile station. The system of the present invention comprises: a system for scanning a home band to locate a control channel; a system for obtaining, when the control channel is located, a system identification number corresponding to a current service area in which the mobile station is located; a system for determining whether the home system is available based on the system identification number of the current service area; a system for accessing, when the home system is not available, a system access list (SAL) stored in the mobile station, the SAL comprising a plurality of entries indicating a system identification number and corresponding frequency band for each preferred system; a system for comparing the system identification number of the current service area to the entries of the SAL to determine whether a preferred system exists for the current service area; and a system for identifying, from one of the entries of the SAL that corresponds to the system identification number of the current service area, a frequency band where the mobile station can locate a preferred system for the current service area.

The comparing system may comprise a system for determining that a preferred system exists when a system identification number of one of the entries corresponds to the system identification number of the current service area. The system may also include a system for scanning, when a current frequency band in which the control channel is located does not correspond to an identified frequency band of the preferred system, the identified frequency band to obtain service on the preferred system for the current service area. In addition, the system may comprise a system for obtaining service on the current frequency band when the current frequency band corresponds to the identified frequency band of the preferred system.

Fig. 10 is a general block diagram of an exemplary network architecture for implementing and administering the intelligent roaming capabilities of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings, a detailed description of the preferred embodiments and features of the present invention will be provided.

The present invention relates to a mobile station with intelligent roaming and/or over-the-air programming features. The present invention permits a mobile station to rapidly obtain service on a preferred cellular or PCS system, when there are multiple bands and multiple air-interface technologies available. According to an aspect of the present invention, a System Access List (SAL) is stored within a memory or storage device of the mobile station. When the mobile station is roaming, the SAL may be accessed to indicate the band or bands where the mobile station will find a preferred system. The SAL may also include information to indicate the air-interface technology supported on each of the preferred bands, to assist the mobile station in finding a system of a given technology type. According to another aspect of the present invention, programming of the SAL in the mobile station may be performed over the air (i.e., by wireless communication) to permit easy reprogramming of the mobile station with new preferred system information as it becomes available.

These and other features and aspects of the present invention will now be described in greater detail with reference to the accompanying drawings.

Figs. 2A-2C illustrate an exemplary network architecture and exemplary system components for implementing the intelligent roaming capabilities of the present invention. In Figs. 2A-2C, a mobile station-based approach is provided for implementing the intelligent roaming capabilities of the invention. According to the mobile-station approach of the invention, each mobile station is programmed with intelligent roaming capabilities so that it can determine which system it should obtain service on prior to registration. As will be appreciated from the following description, the mobile station-based approach for providing intelligent roaming capabilities has several advantages, including the ability to integrate into conventional cellular or PCS network environments without requiring modification to the main network components, and without requiring any changes to current network interface standards (e.g., IS-41) or air interface standards

actual cell coverage area for a cell site will depend upon various factors, including the power of the transceiver of the cell site, the placement and location of the cell site, and the topography of the locality and surrounding areas where the cell site is located. Further, although only two cell sites are depicted in Fig. 2A, the cellular network may of course include more than two cell sites. Moreover, it should be noted that the various components of the cellular network depicted in Fig. 2A are provided for the purpose of illustration only, and that other type of network arrangements may of course be provided to implement the features of the invention. In addition, more that one cell site may of course be served by each MTSO.

Various air-interface technologies (e.g., TDMA, CDMA, PACS, and PCS-1900 MHz) may be utilized to facilitate communication between the mobile station and the cell sites. Each of the cell sites 75 and 95 may include, for example, a radio transceiver (not shown) and be connected by landlines 32 or other communication links to Mobile Switching Centers (MSCs) or Mobile Telephone Switching Offices (MTSOs) 54 and 58. Landlines 32 may also be utilized to connect the MTSOs 54 and 58 to Public Switch Telephone Network (PSTN) 82.

The MTSOs 54 and 58 may be conventional digital telephone exchanges that control the switching between PSTN 82 and the cell sites 75 and 95 to provide wireline-to-mobile, mobile-to-wireline and mobile-to-mobile call connectivity. The MTSOs may provide various functions, including (i) processing mobile station status data received from the cell site controllers, (ii) handling and switching calls, (iii) processing diagnostic information, and (iv) compiling billing information. The transceiver (not shown) of each cell site 75 and 95 may provide communication services, such as voice and data communication, with mobile station 68 while it is present in its cell coverage area. Tracking and switching of the mobile station from cell site to cell site may be handled by the MTSOs, as the mobile station passes through various cell coverage areas. When, for example, mobile station 68 passes from one cell to another cell, the MTSO of the corresponding cell may perform a "hand-off" that allows the mobile station to be continuously serviced.

As shown in Fig. 2B, the mobile station 68 may be implemented as a cellular telephone unit that comprises an antenna 62, a speaker 64, a microphone 69, a display 65,

transceiver 63, which in turn is connected to a control system 61. Control system 61 may be implemented as a microprocessor-based, control system and may be programmed to carry out the intelligent roaming features and logic of the present invention. The programming of control system 61 may be carried out by any suitable combination or use of software, hardware and/or firmware. Control system 61 may control the various components of the mobile station 68 to permit a user to send and receive calls and program the mobile station. In addition, control system 61 may have access to memory 67, in which the SAL and other programming information is stored, for directing operation of the mobile station. A more detailed description of the various processes and functions of the intelligent roaming features of the present invention, as well as the logic steps associated with the intelligent roaming method, is provided below with reference to the accompanying drawings.

Referring now to Fig. 3, an exemplary logic flow diagram of the intelligent roaming process or method of the present invention will be discussed, in accordance with an embodiment of the present invention. The various processes and operations illustrated in Fig. 3 may be carried out by control system 61 of the mobile station 68 through the use of programmed logic or firmware. The intelligent roaming process of the present invention permits each mobile station to automatically obtain service on the most appropriate and/or preferred cellular system. Although the description below is made with reference to a cellular network environment, the various processes and operation may also be applied to PCS or PCN network systems.

In Fig. 3, a mobile station enters an initialization state at step S.2, when the mobile station is powered ON, changes systems, is in a "No Service" condition, or when an Intelligent Roaming mode (IR Mode) has been selected by the user. After the mobile station has been initialized, the mobile station first scans for its home band (i.e., the set of frequencies corresponding to its home network system) at step S.4 to locate a control channel. The set of frequencies corresponding to the home band of the mobile station may be programmed into the mobile station's memory (e.g., memory 67) by the home system service provider.

At step S.6, the mobile station determines whether it is in its home system. Whether or not the mobile station is located in its home system may be determined by

provided in the mobile station 68 of the present invention may have to be implemented with a memory capacity that is larger than that of, for example, conventional mobile stations. However, the capacity of the memory may be limited by restricting the SAL to contain entries only for SIDs on the home and secondary bands. By comparing the broadcasted SID of the current system with the SIDs of the entries in the SAL, the mobile station can determine, at step S.12, whether the current system is a preferred system (i.e., whether the current system corresponds to a preferred service provider that has a service agreement or billing arrangement with the user's home network service provider).

If the current system corresponds to a preferred system for the area in which the mobile station is located, then at step S.14 the mobile station will stay on that band and obtain service from the preferred system. If, however, the current system is not the preferred system for the given area, the SAL will indicate the band or bands where the mobile station will find a preferred system, and the mobile station will obtain service from the indicated band(s) at step S.16. Thus, the mobile station may obtain service by switching to the indicated band of the preferred system without having to randomly scan bands until a preferred system is located.

Additional features may be incorporated into the embodiment of Fig. 3. For example, if a control channel cannot be located on the home band at step S.4, an indication may be displayed to the mobile station user to indicate that "No Service" is available. In addition, in accordance with another aspect of the invention, when no control channels are found on the home band at step S.4, a defined secondary band may be scanned by the mobile station to locate a control channel. The secondary band may be defined and set up as a band in which the mobile station is guaranteed of finding a control channel (e.g., either the A band or B band at 800 MHz). The frequencies of the secondary band that should be scanned by the mobile station may be stored in the memory of the mobile station. If a control channel is found on the secondary band, then logic could proceed directly from step S.4 to step S.10 to determine if the current system is a preferred system. Thereafter, service may be obtained in accordance with steps S.12-S.16 in Fig. 3.

According to an aspect of the present invention, the SAL that is stored in the mobile station may include various information for each SID entry that is stored. This

are executed. If it is determined that the IR Mode has not been selected (e.g., by checking the status of a stored, IR Mode status flag), then at step S.26 conventional roaming or roaming according to Preferred System Selection logic may be performed. If, however, it is determined that the mobile station is in an IR Mode at step S.30, then logic proceeds to step S.36. Logic flow will also proceed from step S.34 to step S.36, whenever the IR Mode is selected by the user.

At step S.36, the mobile station scans the frequency band of the home system to locate a control channel (CCh). The control channel may either be an analog control channel (ACC) or a digital control channel (DCCH), and the home frequency band that should be scanned may be stored in memory of the mobile station. At step S.38, it is determined whether a control channel has been located. If the mobile station determines that a control channel has been found at step S.38, then at step S.46 it is determined whether the mobile station is located in its home system. Step S.46 may be determined by comparing the SID or equivalent system identification number of the current system that was received over the control channel with the home SID of the mobile station's home service provider. If the current SID corresponds to the home SID, then it is determined at step S.46 that the mobile station is located in its home system and logic proceeds to step S.50, which is illustrated in Fig. 5 and described in greater detail below. If the current SID does not correspond to the home SID, then it is determined at step S.46 that the mobile station is not located in its home system and logic proceeds to step S.58 (see Fig. 5).

If it is determined at step S.38 that a control channel cannot be located on the home band, then logic proceeds to step S.40 where a secondary band may be scanned by the mobile station so that a control channel may be located. In accordance with an aspect of the present invention, a defined secondary band may be scanned by the mobile station when no control channels are found on the home band. The secondary band should be defined and set up as a band in which the mobile station is guaranteed of finding a control channel (e.g., either the A band or B band at 800 MHz). The frequencies of the secondary band that should be scanned by the mobile station may be stored in the memory of the mobile station. If a control channel is found on the secondary band at step S.42, then logic proceeds to step S.58 in Fig. 5. Otherwise, if a control channel can not

When it is determined at step S.46 that the mobile station is located in its home system, logic proceeds to step S.50 in Fig. 5. At step S.50, a periodic scan flag (P_Scan) is initialized and set to zero. The P_Scan flag may be stored in the mobile station and may be provided to indicate when the mobile station should periodically scan for preferred or target systems after obtaining service on the current system. If, for example, the P_Scan flag is set to one, then this flag will indicate to the mobile station that it should periodically scan for target systems after obtaining service on the current system. If, however, the P_Scan flag is set to zero, then periodic scanning is not necessary. At step S.50, the P_Scan flag is set to zero, since the mobile station is in its home system and scanning is not required.

After step S.50, the mobile station completes an Initialization Task or a Control Channel Selection procedure at step S.52 in order to obtain service on the home network system. The Initialization Task and Control Channel Selection procedures may be defined and performed in accordance with Interim Standard 136 (IS-136). The Initialization Task procedure should be performed when an analog control channel (ACC) is being used, whereas the Control Channel Selection procedure should be performed when a digital control channel (DCCH) is being used to obtain service. Following step S.52, a Home SID Alpha Tag (e.g., an alphanumeric tag such as "Home" and/or the name of the home network system) or other type of indication (e.g., a Home SID icon or status light) may be displayed at step S.54 to indicate to the mobile station user that it is operating on its home system. The Home SID Alpha Tag may be displayed, for example, on the display 65 of the mobile station 68. Thereafter, logic proceeds to step S.94, which is illustrated in Fig. 7 and described in greater detail below.

When it is determined at step S.46 that the mobile station is not located in its home system, logic proceeds to step S.58 in Fig. 5. As shown in Fig. 5, the periodic scan (P_Scan) flag is initialized and set to zero at step S.58. The P_Scan flag is set to zero at step S.58 since the mobile station has located a control channel (although not for the home SID) and it is unknown whether the current system is a preferred system. Once again, the P_Scan flag may be provided to indicate when the mobile station should periodically scan for preferred or target systems after obtaining service on the current system. If, for example, the P_Scan flag is set to one, then the mobile station should

If there are no target or preferred systems for the given SID, then logic proceeds to step S.66, where an Initialization Task or Control Channel Selection procedure is completed by the mobile station. Thereafter, at step S.68, it is determined whether a roam indicator (Roam_Ind) bit is equal to zero. In accordance with the present invention, a Roam_Ind bit may be provided to indicate when a roam indication (e.g., a Roam Indicator or a Roaming SID Alpha Tag) should be displayed by the mobile station to indicate to the user that the mobile station is roaming. The Roam_Ind bit may be stored in the mobile station. For example, the Roam_Ind bit may be stored and provided as a bit field within each of the SAL entries for the current system (see, e.g., Table 11) and/or the preferred or target system (see, e.g., Table 14). When, for example, the Roam_Ind bit is equal to one, the mobile station will display the roam indication to the user. If, however, the Roam_Ind bit is equal to zero, then the roam indication will not be displayed. The mobile station may analyze the Roam_Ind bit for the system that it will receive service on (i.e., the current system or a target system) in order to determine whether to display a roam indication.

If it is determined at step S.68 that the Roam_Ind bit is set to zero, then the roaming indication should not be displayed and logic flow proceeds to step S.70. If, however, the Roam_Ind bit is not equal to zero (i.e., the bit is set to one), then logic flow will proceed to step S.74, as illustrated in Fig. 5. As discussed above, when the Roam_Ind bit is set to one, the mobile station will be instructed to display the roaming indication. At step S.74, the Roam Indicator (e.g., a roam icon or a dedicated status light) and/or a Roaming SID Alpha Tag (e.g., a alphanumeric tag such as "Roaming" and/or the name of the current network system) are displayed to the mobile station user to indicate a roaming condition. Thereafter, logic flow will proceed to step S.94, which is discussed below with reference to Fig. 7.

If the Roam_Ind bit is set to zero, then at step S.70 it is determined whether a SID Alpha Tag Control (SAT_Ctrl) bit is set to one. The SAT_Ctrl bit may be provided to indicate when a Home SID Alpha Tag (e.g., an alphanumeric tag such as "Home" and/or the name of the home network system) should be displayed by the mobile station to indicate to the user that the mobile station is operating on its home system or operating in a system affiliated or owned by its home service provider. The SAT_Ctrl bit may be

the mobile station has scanned for a target system after obtaining service on the current system, may be initialized and set to zero at step S.76. Moreover, a scan time constant or value (T_Scan) between periodical scans by the mobile station may be set to a predetermined time interval. By way of non-limiting examples, the T_Scan value may be set to two and one-half minutes or five minutes. After initializing and setting the various operational parameters at step S.76, logic flow proceeds to step S.66, which is described above with reference to Fig. 5.

If the Scan Method bit field is determined at step S.78 to be equal to zero, then at step S.80 it is determined whether one or more target systems exist for the current SID. The mobile station may determine if there are more target systems by analyzing the target system information provided in the SAL entry corresponding to the current SID. Each SID entry in the SAL may have a list of one or more target systems, that are each analyzed and processed by the mobile station in turn, starting with the first identified system. The SAL entry corresponding to the current SID may contain information indicating the number of target systems that exist (see, e.g., Table 11). If service can not be obtained on a target system identified by the SAL, the mobile station will proceed to the next target system if more target systems exist in the SAL entry. The mobile station may sequentially check each of the target systems in the SAL entry until a suitable target system is located. When analyzing the first target system in the SAL entry at step S.80, logic flow will proceed from step S.80 to step S.86. Additionally, for subsequent checks of target systems identified in the SAL, when it is determined that more target systems exist at step S.80, then logic will also proceed from step S.80 to step S.86.

If it is determined at step S.80 that there are no more target systems, then at step S.82, it is determined whether the Scan Method bit field is equal to zero. If it is determined at step S.82 that the Scan Method bit field is equal to zero, then logic proceeds to step S.44 (see Fig. 4), so that a "No Service" indication may be displayed to the mobile station user. If it is determined at step S.82 that the Scan Method bit field does not equal zero, then logic proceeds to step S.84 to increment the scan count (S_Count) counter by one. As noted above, a S_Count counter may be provided to indicate how many times the mobile station has scanned for a target system after

target systems are identified in the SAL for the current SID and, if so, to perform subsequent scanning to locate a preferred system.

Fig. 7 illustrates the various processes and operations that are performed at steps S.94-S.104 of an embodiment of the intelligent roaming process of the present invention. At step S.94, the mobile station enters into an Idle state or a Camping state for the current or located system. The mobile station may enter into an Idle state when an analog control channel (ACC) has been located. If, however, a digital control channel (DCCH) is located, then the mobile station may enter into a Camping state. During the Idle or Camping state, the mobile station is waiting for information to be sent via the control channel. For example, with a DCCH, the mobile station may enter a Camping state when it is on a control channel and waiting to receive a page.

At step S.96, the periodic scan (P_Scan) flag may be analyzed to determine whether the mobile station should periodically scan for target systems after obtaining service on the current system. If the P_Scan flag is set to one (i.e., indicating that the mobile station should periodically scan for target systems), then logic proceeds to step S.98. If, however, it is determined that the P_Scan flag is not set to one at step S.96, then logic returns to step S.94 in Fig. 7. Logic will proceed from step S.96 to step S.94 whenever the mobile station locates a target system and the P_Scan flag is set to zero, since it is not necessary for the mobile phone to scan for other systems.

At step S.98, the mobile station determines whether the scan count (S_Count) counter is equal to zero. As described above, a S_Count counter may be provided to indicate how many times the mobile station has scanned for a target system after obtaining service on the current system. If it is determined that the S_Count counter is equal to zero, then logic proceeds to step S.102. On the other hand, if it is determined that the S_Count counter does not equal zero, then logic proceeds to step S.100, where it is determined if the scan time (T_Scan) has elapsed since the last scan. In accordance with an aspect of the present invention, a clock-based, scan timer (S_Timer) may be provided to monitor and keep track of the elapsed time between scans by the mobile station. The value of the S_Timer may be compared with the selected T_Scan value (e.g., two and one-half minutes or five minutes) to determine if the interval between periodic scans for a target system has elapsed. If the value of the S_Timer is less than the T_Scan

accordance with the invention, over-the-air programming of the SAL may be accomplished as part of the Over-the-Air Activation Teleservice (OATS) defined in the Addendum to Interim Standard 136A (IS-136A) of the North American Cellular System, or as a different teleservice. A teleservice is generally an end-to-end data application between a mobile station and a network entity (e.g., a Message Center or Over-the-Air Activation Function (OTAF)) that is typically independent of and transparent to a Base Station/Mobile Switching Center/Interworking Function (BMI). The BMI provides the teleservice transport, but is not directly involved in processing the actual teleservice data. For additional information concerning OATS, OTAF and BMI, see the Addendum to IS-136 Revision A contained in TIA/EIA/IS-136.1-A-1, Addendum No. 1 to TIA/EIA/IS-136.1-A, Telecommunications Industry Association, November 1996, the disclosure of which is expressly incorporated herein by reference in its entirety.

According to one embodiment of the present invention, the over-the-air programming of the SAL may be made part of OATS, by standardizing and providing new information elements to program the mobile station with the SAL and intelligent roaming data (see, for example, Fig. 8 and the accompanying description provided below). Alternatively, in accordance with another embodiment of the present invention, the over-the-air programming of the SAL may be made part of the OATS by embedding the new information as messages within the System Operator Code (SOC) Specific Request message defined for OATS. The System Operator Code (SOC) is a twelve bit value that is broadcasted on the control channel (normally a DCCH) and used to identify which operator is providing service. In the two embodiments described below, if an SAL entry is a duplicate of another SAL entry already stored in the mobile station, then a new SAL entry may overwrite the old SAL entry in memory. In addition, if there is a large quantity of SAL information that needs to be stored in the mobile station, the initial downloading of all of the SAL information may be performed by a physical interface or connection (e.g., during manufacture of the mobile station), and subsequent updates or reprogramming of specific data in the SAL may be performed over-the-air.

Fig. 8 illustrates, in accordance with an embodiment of the present invention, an exemplary diagram of message flows between a Mobile Station (MS) and the Base Station/Mobile Switching Center/Interworking Function (BMI) for implementing over-

provided herein, the new information elements and modifications to the OATS-based messages are underlined in the tables.

Table 1: Configuration Data Request

Information Element	Type	Length
Message Type	M	6
Remaining Length (in Octets)	M	8
Configuration Data Block Map	M	16

As shown in Table 1, the Configuration Data Request may be modified to include a new entry in the Configuration Data Block Map. The Configuration Data Block Map is an information element or data message that provides a list of the Configuration Data Blocks for which the BMI requests configuration information from the MS. As shown below in exemplary embodiment of Table 2, the Configuration Data Block Map may include specific values for a NAM Configuration Data Block request and a Non-Public System Configuration Data Block request. In addition, according to the present invention, values may be provided for a Band Info request and System Access List request for the purpose of programming the mobile station. A more detailed discussion of the Band Info and System Access List data blocks of the present invention is provided below. In Table 2, and the subsequent tables, the value "X" (where present) represents that the value may be assigned either a value of zero or value of one.

Table 2: Configuration Data Block Map

Value	Function
XXXX XXXX XXXX XXX1	NAM Configuration Data Block requested
XXXX XXXX XXXX XX1X	Non-Public System Configuration Data Block requested
XXXX XXXX XXXX X1XX	Band Info requested
XXXX XXXX XXXX 1XXX	System Access List requested
All other values may be reserved	

Table 3B: Parameter Codes for Optional Information Elements

Parameter Type	Code
NAM Configuration Data Block	0001
Non-Public Configuration Data Block	0010
System Operator Code (SOC)	0011
Index Code	0100
Band Info	0101
System Access List	0110

As shown in Table 3A, the Configuration Data Response message of the present invention is similar to the Configuration Data Response for OATS except that for the invention a Band Info information element and a System Access List information element are also included in the message. The Band Info information element may contain data that identifies, for example, the home band and the secondary band, as well as other data to support intelligent roaming. The System Access List information element may contain SAL data entries for the mobile station to use in identifying the preferred system(s) to access in an intelligent roaming mode. Examples of the data fields for the Band Info and System Access List information elements are provided below with reference to Tables 5 and 10, respectively. Exemplary parameter type codes that may be used for the optional information elements of the Configuration Data Response of Table 3A are provided in Table 3B. As shown in Table 3B, new parameter type codes may be provided for the Band Info and the System Access List information elements.

Referring to Fig. 8, after the Configuration Data Response message has been sent to the BMI, a Download Request message is sent to the MS at step S.216. The Download Request message is sent to the mobile station in order to download specific configuration data. According to the present invention, the Download Request message may be modified to include the Band Info and System Access List information elements. An example of the modified Download Request Message is shown in Table 4A, and Table 4B includes exemplary parameter type codes that may be used for the optional information elements in the Download Request message of Table 4A.

Table 5: Band Info

Field	Length
Parameter Type	4
SID Alpha Tag Control	1
Home Band	3
Probability Block Map	16
Secondary Band	3

In the Band Info information element, a Parameter Type code (e.g., 0011) may be included to indicate the parameter type, and a SID Alpha Tag Control field (i.e., a SAT_Ctrl field) may be included to indicate when the Home SID Alpha Tag should be displayed. If, for example, the SID Alpha Tag Control field is set to one, then the mobile station will be instructed to display the Home SID Alpha Tag. If, on the other hand, the SID Alpha Tag Control field is set to zero, the Home SID Alpha Tag will not be displayed. A Home Band field may also be provided in the Band Info information element to indicate the frequency band for the home system. Further, as shown in Table 5, a Probability Block Map field may also be provided to indicate the most likely probability blocks in which a control channel may be found by the mobile station. Tables 8 and 9 are, respectively, exemplary Home Band and Probability Block Map fields that may be utilized to implement the features of the present invention.

As further shown in Table 5, the Band Info information element may include a Secondary Band field. The Secondary Band field may be provided to identify the secondary frequency band for the mobile station to scan if no acceptable control channels can be found on the home band. The Secondary Band field may be coded in a similar manner to the Home Band field described below (see, for example, Table 8).

In response to the Download Request message from the BMI at step S.216, a Download Result message is sent at step S.220 from the MS to the BMI. In accordance with the present invention, the Download Result message may be a modified OATS message that includes a Download Result Map information element. The Download Result Map information element provides feedback to the BMI on the results of the data block downloads. Table 6A illustrates an exemplary, modified Download Result

Table 7: Download Result Map

Value	Function
XXXX XXXX XXXX XXX0	NAM download unsuccessful
XXXX XXXX XXXX XXX1	NAM download successful
XXXX XXXX XXXX XX0X	Non-Public download unsuccessful
XXXX XXXX XXXX XX1X	Non-Public download successful
XXXX XXXX XXXX X0XX	Band Info download unsuccessful
XXXX XXXX XXXX X1XX	Band Info download successful
XXXX XXXX XXXX 0XXX	System Access List download unsuccessful
XXXX XXXX XXXX 1XXX	System Access List download successful
All other values may be reserved	

After step S.220 in Fig. 8, the subsequent OATS messages may be sent in standardized format to complete the over-the-air programming of the mobile station. That is, at step S.224, a NAM Commit Result message may be sent from the BMI to the MS, and then a CSC Challenge Request message may be sent at step S.228 from the MS to the BMI. Thereafter, at step S.232, a CSC Challenge Response message may be sent to the MS, and then a NAM Commit Result may be sent from the MS to the BMI in step S.236. At this point, the SAL and other intelligent roaming data is updated in the memory of the MS, and the MS may proceed to perform intelligent roaming with the updated information.

As described above, the message flow for over-the-air programming of the mobile station may be achieved by utilizing new information elements that are sent based on an OATS message flow. According to an aspect of the present invention, the existing OATS messages that are modified to include these new information elements include, for

Table 9 illustrates an exemplary coding of values for the Probability Block Map field. The Probability Block Map field may be provided as one of the fields in the Band Info information element, as discussed above with reference to Table 5. The Probability Block Map field indicates the most likely probability blocks in which a control channel may be found by the mobile station. The probability block members may be defined in accordance with Interim Standard 136.1 (IS-136.1), Revision A, Section 6.3.1.1.1 for each frequency band. For more information on IS-136.1, see for example TIA/EIA-IS-136.1-A, TDMA Cellular/PCS- Radio Interface-Mobile Station-Base Station Compatibility-Digital Control Channel, Telecommunications Industry Association, October 1996, the disclosure of which is expressly incorporated herein by reference in its entirety.

Table 9: Probability Block Map

Value	Function
1XXX XXXX XXXX XXXX	1st probability block likely to contain control channels
0XXX XXXX XXXX XXXX	1st probability block unlikely to contain control channels
. . .	. . .
XXXX XXXX XXXX XXX1	16th probability block likely to contain control channels
XXXX XXXX XXXX XXX0	16th probability block unlikely to contain control channels

Table 10 illustrates the various fields that may be provided for the System Access List information element. As discussed above, the System Access List information element may be included in the Configuration Data Response message (see step S.212) and the Download Request message (see step S.216). The System Access List information element may contain SAL entries for the mobile station to use in identifying the preferred system to access when in an intelligent roaming mode. As shown in Table 10, the System Access List information element may include a field to indicate the number of SAL entries that are present (e.g., a Number of Target Systems field), and may

indicator should be displayed by the mobile station for the current system. For example, when the Roam Indicator field is set to one, this field will indicate that the mobile station should display the roam indicator. If, however, the Roam Indicator field is set to zero, the roam indicator should not be displayed by the mobile station.

The Scan Method field of each SAL entry may indicate how the mobile station should scan for a target system. Table 12 illustrates an example of the coded values that may be assigned to the Scan Method bit field, as well as the related function for each coded value. If, for example, the Scan Method field has a value of zero, then the mobile station should perform a continuous scan until it finds a target system. If, on the other hand, the Scan Method field is equal to one, then the mobile station should obtain service on the current SID and scan for target or preferred systems periodically.

Table 12: Scan Method

Value	Function
00	Continuous scan until find a target system
01	Obtain service on current SID and scan for target systems periodically
All other values may be reserved	

The Scan Time field of each SAL entry indicates the approximate interval between scans for a target system. Table 13 illustrates various coded values that may be assigned to the Scan Time field. The scan time interval may be set based upon various factors, including the operating conditions of the mobile station. For example, the battery power of the mobile station may effect the scan time interval, such that a longer scan time interval may be desirable to reduce the number of required scans and consumption of the battery. By way of a non-limiting example, a scan time interval of two and one-half or five minutes may be utilized. As shown in the embodiment of Table 13, if the Scan Time field is set to zero, then the scan time will be set such that the mobile station will perform a scan every two and one-half minutes. If the scan time is set to one, then a longer scan time may be used by the mobile station. For example, in Table 13, a scan time field value of one would cause the mobile station to perform a periodical scan every five minutes.

Info may indicate to the mobile station when a roaming status indication should be displayed when service is obtained on a particular target system. When the Roam Indicator field is set to one, for example, this field may indicate that the mobile station should display the roaming status indication. Otherwise, if the value of the Roam Indicator field is set to zero, the roaming status indication should not be displayed by the mobile station.

As part of the target system information in the Target System Info data block, a Technology Map field may also be provided. The Technology Map field may identify the air-interface technologies (e.g., EIA/TIA-553 (AMPS), IS-136, PCS-1900, etc.) and/or other technologies associated with a particular frequency band of a given target system. Table 15 illustrates examples of the various coded values that the Technology Map field may be assigned to indicate a particular air-interface technology. In the embodiment of Table 15, the unassigned bit values may be held in reserve for future systems or applications (e.g., they could be assigned to PACS, CDMA, or other technologies).

Table 15: Technology Map

Value	Function
X XXX1	EIA/TIA-553 (AMPS)
X XX1X	IS-136
X X1XX	PCS-1900
All other values may be reserved	

Other information relating to each target or preferred system may also be provided as part of the information fields for the Target System Info. For example, a Probability Block Map field may be provided to indicate the most likely probability blocks in which a control channel may be found. An example of the manner in which a Probability Block Map field may be coded is provided above with reference to Table 9.

In accordance with another embodiment of the present invention, the SAL and intelligent roaming information may be downloaded and programmed into the mobile station by embedding the over-the-air programming messages within the SOC Specific Request message defined for OATS. According to this embodiment, the BMI will send

example, Tables 5, 10 and 11). Table 17B illustrates an example of the parameter type codes for the optional information elements in the SOC Specific Data information element of Table 17A.

Table 17A: SOC Specific Data

Information Element	Type	Length
Band Info	0	26
System Access List	0	35 - *

Table 17B: Parameter Codes for Optional Information Elements

Parameter Type	Code
Band Info	0001
System Access List	0010

After all of the SOC Specific Request messages have been sent, a NAM Commit Request message may be sent from the BMI to the MS at step S.308. In response, a SOC Challenge Request message will be sent from the MS to the BMI at step S.312, and a CSC Challenge Response will be returned by the BMI to the MS at step S.316. Thereafter, as shown in Fig. 9, a NAM Commit Result message will be sent at step S.320 from the MS to the BMI to confirm the programming of the intelligent roaming data to the mobile station.

Various techniques and network architectures may be utilized for administering, programming and updating each mobile station with the SAL and other intelligent roaming information. For example, a main or centralized database could be established to implement the various aspects of the present invention. Such a centralized database could include information on all of the network systems that the home service provider owns, as well as information on all the systems with which the service provider has preferred roaming agreements or billing arrangements. Entries in the database could encompass, for example, all of the information that is provided to the mobile station as part of the over-the-air programming of the mobile station. Other information could also be included in such a centralized database. For example, the centralized database could

Mobile Station Identity (IMSI). The mobile station identity may also identify the mobile station's Home Location Register (HLR).

As noted above, each of the OTAF/slave SALs 186 may send the formatted information to the mobile stations through the cellular or PCS network. The Base Station/Mobile Switching Center/Inter-Working Function (BMI) may be used to transfer the information to the mobile stations. When information is received from the master SAL 192, the OTAF/slave SAL 186 may send, for example, an Interim Standard 41C (IS-41C) message to the mobile station's HLR to determine the location of the mobile station. The HLR may then respond with an address for the serving systems's MSC or MTSO (such as MTSO 154). As illustrated in Fig. 10, the OTAF/slave SAL 186 may then communicate over-the-air programming messages for the mobile station, such as mobile station 168, via MTSO 154 using the IS-41C SMS Delivery Point-to-Point (SMDPP) message. The MTSO 154 may then repackage the over-the-air message into, for example, an Interim Standard 136 (IS-136) R-DATA message for delivery to the mobile station 168 through an appropriate base station or cell site 175. Feedback may be provided by the serving MTSO 154 to the OTAF/slave SAL 186 (e.g., in the form of another IS-41C message) to indicate whether the information successfully reached the mobile station. If the information was not successfully delivered to the mobile station, the OTAF/slave SAL 186 could trigger a retry mechanism to resend the information.

Other features may be provided for administering and implementing the intelligent roaming capabilities of the present invention. For example, as an alternative to the embodiment of Fig. 10, the home network system could broadcast a code indicating when the central SAL database was last updated. Based on this code, mobile stations could then determine periodically if they have the most current SAL information. When it is determined that the SAL information contained in the mobile station is not current, the mobile station could request reprogramming by sending a request message using, for example, OATS message protocols.

While the invention has been described with reference to several exemplary embodiments, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitations. Changes may be made,

WHAT IS CLAIMED:

1. An intelligent roaming process for enabling a mobile station to locate a preferred system within a communication network when a home system of said mobile station is not available, said communication network comprising a plurality of service areas, each of said service areas being assigned a system identification number, said intelligent roaming process comprising:

accessing, when said home system is not available, a system access list (SAL) stored in said mobile station;

comparing a system identification number of said current service area to said SAL to determine if a preferred system exists for said current service area; and

identifying, when a preferred system is determined to exist for said current service area, a frequency band where said mobile station can locate said preferred system for said current service area.

2. An intelligent roaming process according to claim 1, wherein said SAL comprises a plurality of entries indicating a system identification number and corresponding frequency band for each preferred system, said comparing comprising searching said entries of said SAL based on said system identification number of said current service area and determining that a preferred system exists when a system identification number of one of said entries corresponds to said system identification number of said current service area.

3. An intelligent roaming process according to claim 2, wherein said identifying identifies, when it is determined that a preferred system exists for said current service area, the frequency band of said preferred system from said one of said entries of said SAL that corresponds to said system identification number of said current service area.

4. An intelligent roaming process according to claim 2, wherein said comparing comprises determining that a preferred system does not exist for said current service area when said system identification number of said current service area does not correspond to a system identification number of any of said entries of said SAL, said process further comprising indicating that no service is available when it is determined that a preferred system does not exist for said current service area.

Code (SOC) Specific Request message defined for an Over-the-Air Activation Teleservice (OATS).

13. An intelligent roaming process according to claim 1, wherein said SAL comprises information indicating at least one frequency block to search for a control channel associated with said preferred system, said process further comprising scanning said at least one frequency block to locate said preferred system for said current service area.

14. An intelligent roaming process according to claim 1, wherein said SAL comprises time scan information indicating an interval time between periodic scans for a preferred system, said process further comprising periodically scanning for a preferred system identified by said SAL in accordance with said time scan information.

15. An intelligent roaming process according to claim 1, wherein said SAL comprises system name information including a service provider name of said preferred system, and roam indicator information indicating when said system name information is to be displayed by said mobile station.

16. A process for selecting a preferred system within a communication network when a home system is not available to a mobile station, said communication network comprising a plurality of service areas, each of said service areas being assigned a system identification number, said process comprising:

scanning a home band to locate a control channel;

obtaining, when said control channel is located, a system identification number corresponding to a current service area in which said mobile station is located;

determining whether said home system is available based on said system identification number of said current service area;

accessing, when said home system is not available, a system access list (SAL) stored in said mobile station, said SAL comprising a plurality of entries indicating a system identification number and a corresponding frequency band for each preferred system;

comparing said system identification number of said current service area to said entries of said SAL to determine whether a preferred system exists for said current service area, and determining that a preferred system exists when a system identification

number of said current service area corresponds to said home system identification number.

23. A process for selecting a preferred system according to claim 16, further comprising obtaining service from said home system when it is determined that said home system is available.

24. A process for selecting a preferred system according to claim 16, further comprising programming said mobile station with said SAL over-the-air with a wireless interface, said over-the-air programming including storing said SAL in a memory of said mobile station.

25. A process for selecting a preferred system according to claim 24, wherein said over-the-air programming comprises transmitting SAL information as information elements that are made part of an Over-the-Air Activation Teleservice (OATS).

26. A process for selecting a preferred system according to claim 24, wherein said over-the-air programming comprises embedding SAL information within a System Operator Code (SOC) Specific Request message defined for an Over-the-Air Activation Teleservice (OATS).

27. A process for selecting a preferred system according to claim 16, wherein said SAL further comprises information indicating at least one frequency block to search for a control channel of said preferred system, said process further comprising scanning said at least one frequency block to locate said preferred system for said current service area.

28. A process for selecting a preferred system according to claim 16, wherein said SAL further comprises time scan information indicating an interval time between periodic scans for a preferred system, said process further comprising periodically scanning for a preferred system identified by said SAL in accordance with said time scan information.

29. A process for selecting a preferred system according to claim 16, wherein said SAL further comprises system name information including a service provider name of said preferred system, and roam indicator information indicating when said system name information is to be displayed by said mobile station.

available when it is determined that a preferred system does not exist for said current service area.

34. An intelligent roaming system according to claim 31, wherein said entries of said SAL further comprise air interface technology information that indicates the air interface technology used by said preferred system.

35. An intelligent roaming system according to claim 30, further comprising a system for scanning, after said frequency band of said preferred system for said current service area is identified, said identified frequency band in order to obtain service on said preferred system for said current service area.

36. An intelligent roaming system according to claim 30, further comprising a system for detecting said system identification number of said current service area within which said mobile station is located, and a system for determining whether said home system is available based on said system identification number of said current service area.

37. An intelligent roaming system according to claim 36, wherein said detecting system comprises a system for scanning a home frequency band for said control channel and system for additionally scanning, when said control channel is not located on said home frequency band, a secondary frequency band where said mobile station can locate said control channel.

38. An intelligent roaming system according to claim 36, wherein said determining system comprises a system for comparing said system identification number of said current service area to a home system identification number associated with said home system and a system for determining that said home system is available when said system identification number of said current service area corresponds to said home system identification number.

39. An intelligent roaming system according to claim 30, wherein said mobile station comprises a mobile phone and said communications network comprises one of a cellular communications network and a Personal Communications Services (PCS) network.

40. An intelligent roaming system according to claim 30, further comprising a system for programming said mobile station with said SAL over-the-air with a wireless

an obtaining system for obtaining, when said control channel is located, a system identification number corresponding to a current service area in which said mobile station is located;

a determining system for determining whether said home system is available based on said system identification number of said current service area;

an accessing system for accessing, when said home system is not available, a system access list (SAL) stored in said mobile station, said SAL comprising a plurality of entries indicating a system identification number and corresponding frequency band for each preferred system;

a comparing system for comparing said system identification number of said current service area to said entries of said SAL to determine whether a preferred system exists for said current service area; and

an identifying system for identifying, from one of said entries of said SAL that corresponds to said system identification number of said current service area, a frequency band where said mobile station can locate a preferred system for said current service area.

47. A system for selecting a preferred system according to claim 46, wherein said comparing system comprises a system for determining that a preferred system exists when a system identification number of one of said entries corresponds to said system identification number of said current service area.

48. A system for selecting a preferred system according to claim 46, further comprising a system for scanning, when a current frequency band in which said control channel is located does not correspond to said identified frequency band of said preferred system, said identified frequency band to obtain service on said preferred system for said current service area.

49. A system for selecting a preferred system according to claim 48, further comprising a system for obtaining service on said current frequency band when said current frequency band corresponds to said identified frequency band of said preferred system for said current service area.

50. A system for selecting a preferred system according to claim 46, wherein said comparing system comprises a system for determining that a preferred system does not exist for said current service area when said system identification number of said

information as information elements that are made part of an Over-the-Air Activation Teleservice (OATS).

58. A system for selecting a preferred system according to claim 56, wherein said over-the-air programming system further comprises a system for embedding SAL information within a System Operator Code (SOC) Specific Request message defined for an Over-the-Air Activation Teleservice (OATS).

59. A system for selecting a preferred system according to claim 46, wherein said SAL further comprises information indicating at least one frequency block to search for a control channel of said preferred system, said system for selecting further comprising a system for scanning said at least one frequency block to locate said preferred system for said current service area.

60. A system for selecting a preferred system according to claim 46, wherein said SAL comprises time scan information indicating an interval time between periodic scans for a preferred system, said system for selecting further comprising a system for periodically scanning for a preferred system identified by said SAL in accordance with said time scan information.

61. A system for selecting a preferred system according to claim 46, wherein said SAL comprises system name information including a service provider name of said preferred system, and roam indicator information indicating when said system name information is to be displayed by said mobile station.

62. An intelligent roaming process according to claim 1, further comprising analyzing scan method information in said SAL when more than one preferred system is determined to exist for said current service area, and instructing said mobile station to scan for the preferred systems in accordance with said scan method information.

63. An intelligent roaming process according to claim 62, wherein said mobile station is instructed, in accordance with said scan method information, to scan for the preferred systems determined for said current service area until one of the preferred systems is located.

64. An intelligent roaming process according to claim 62, wherein said mobile station is instructed, in accordance with said scan method information, to obtain service

mobile station to scan for the preferred systems in accordance with said scan method information.

72. A system for selecting a preferred system according to claim 71, wherein said mobile station is instructed, in accordance with said scan method information, to scan for the preferred systems determined for said current service area until one of the preferred systems is located.

73. A system for selecting a preferred system according to claim 71, wherein said mobile station is instructed, in accordance with said scan method information, to obtain service on the current system for said current service area before periodically scanning for the preferred systems for said current service area.

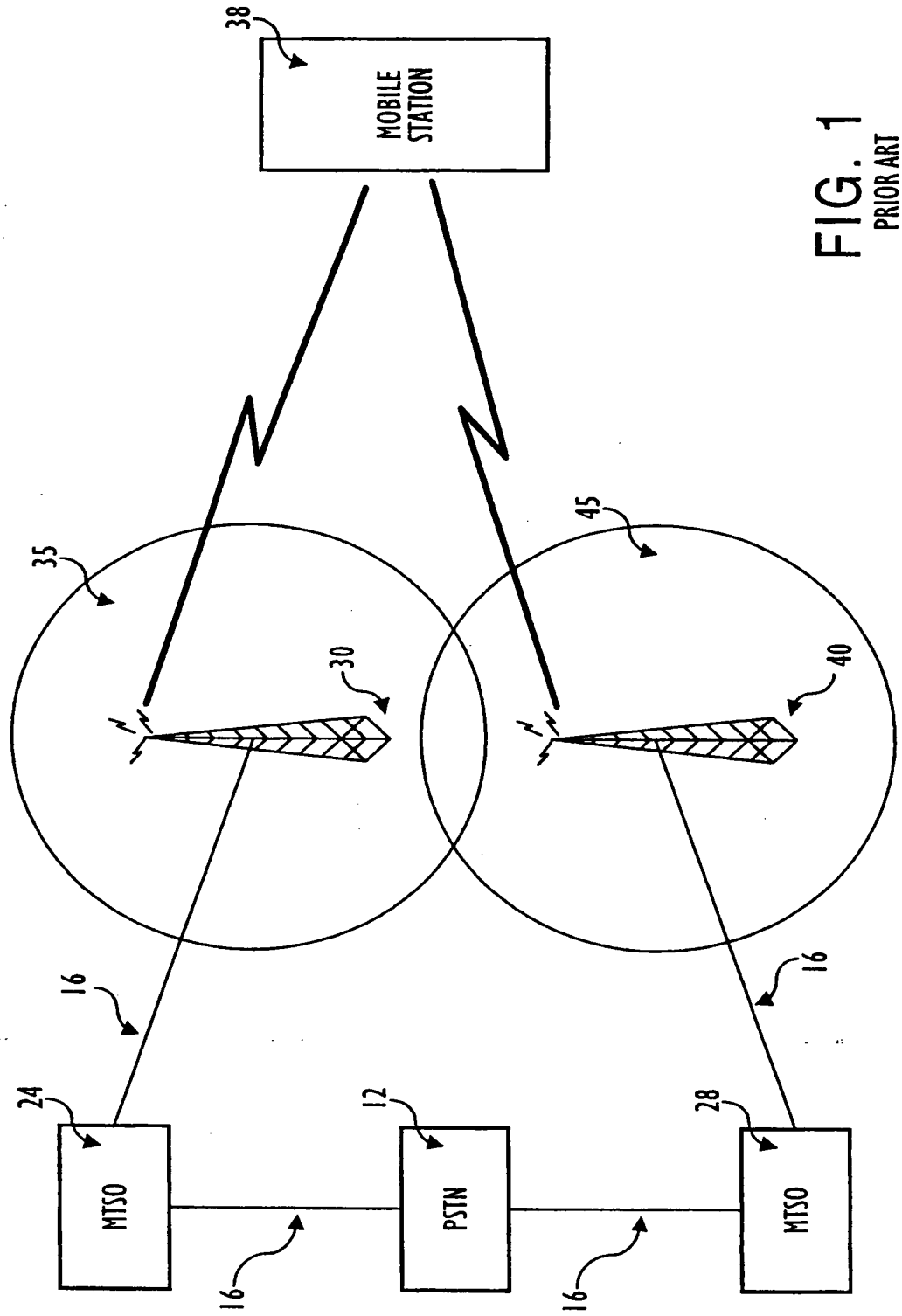


FIG. 1
PRIOR ART

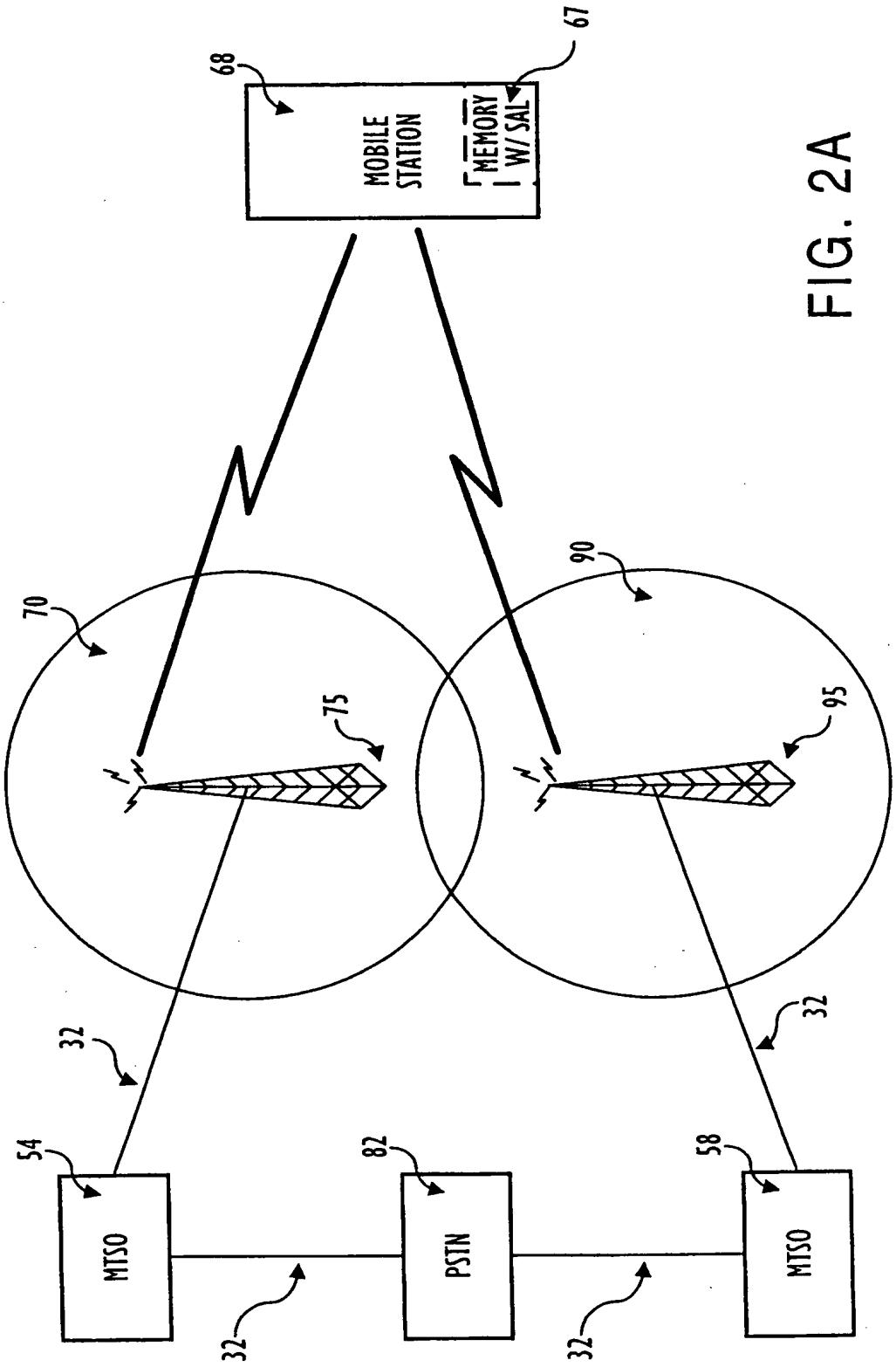

67
68
MOBILE STATION
MEMORY W/ SAL
70
90
75
95
32
32
54
82
58
MTSO
PSTN
MTSO
32
32

FIG. 2A

FIG. 2B

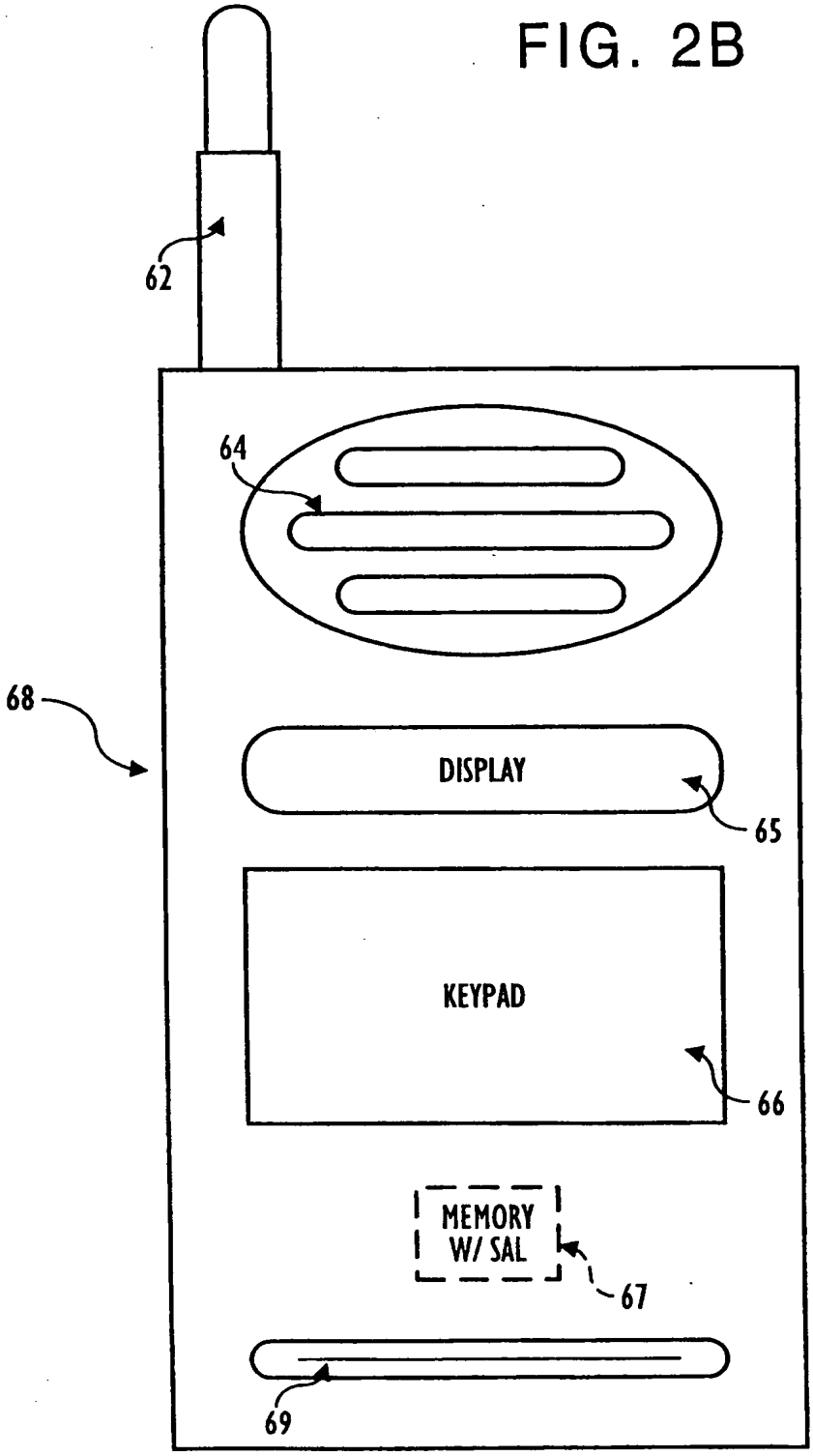


FIG. 2C

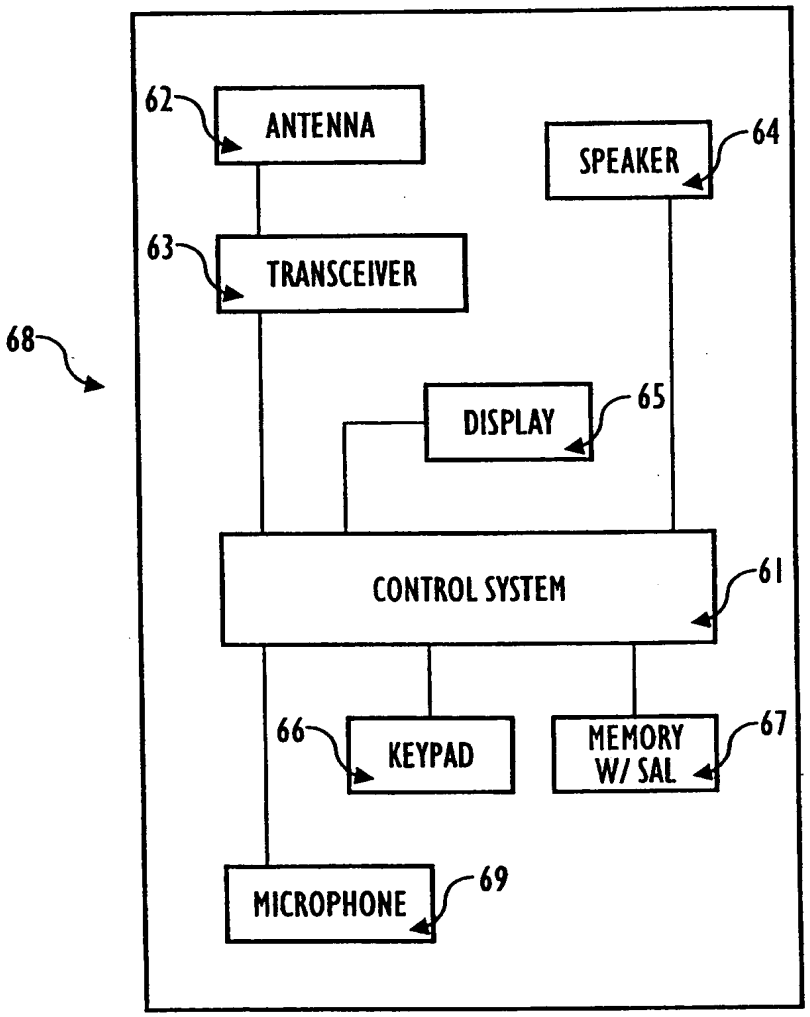

62
ANTENNA
64
SPEAKER
63
TRANSCEIVER
68
65
DISPLAY
CONTROL SYSTEM
61
66
KEYPAD
MEMORY W/ SAL
67
MICROPHONE
69

FIG. 3

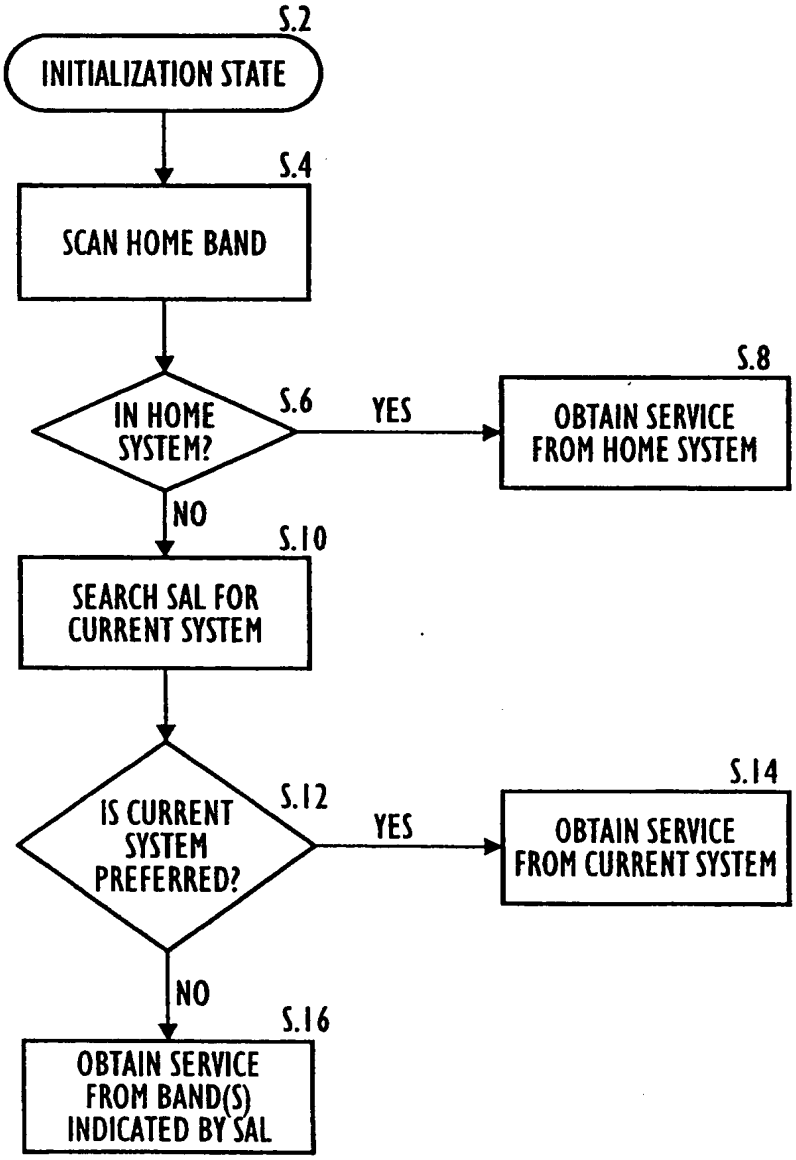

S.2
INITIALIZATION STATE
S.4
SCAN HOME BAND
S.6
IN HOME SYSTEM?
YES
S.8
OBTAIN SERVICE FROM HOME SYSTEM
NO
S.10
SEARCH SAL FOR CURRENT SYSTEM
S.12
IS CURRENT SYSTEM PREFERRED?
YES
S.14
OBTAIN SERVICE FROM CURRENT SYSTEM
NO
S.16
OBTAIN SERVICE FROM BAND(S) INDICATED BY SAL

FIG. 4

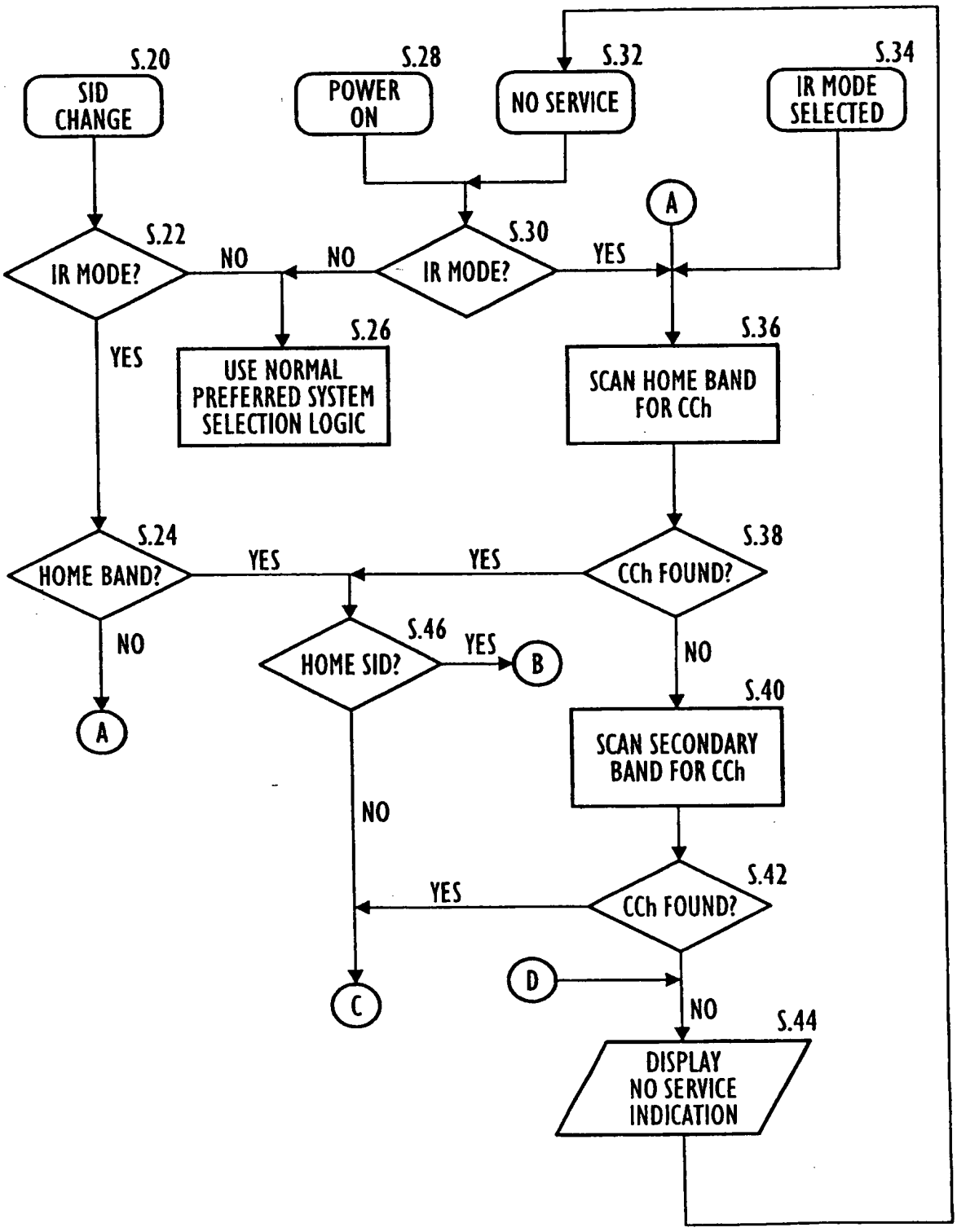

S.20
SID CHANGE
S.28
POWER ON
S.32
NO SERVICE
S.34
IR MODE SELECTED
A
S.22
IR MODE?
NO
NO
S.30
IR MODE?
YES
S.26
USE NORMAL PREFERRED SYSTEM SELECTION LOGIC
S.36
SCAN HOME BAND FOR CCh
YES
S.24
HOME BAND?
YES
YES
S.38
CCh FOUND?
NO
S.46
HOME SID?
YES
B
NO
A
S.40
SCAN SECONDARY BAND FOR CCh
NO
S.42
CCh FOUND?
YES
D
C
NO
S.44
DISPLAY NO SERVICE INDICATION

FIG. 5

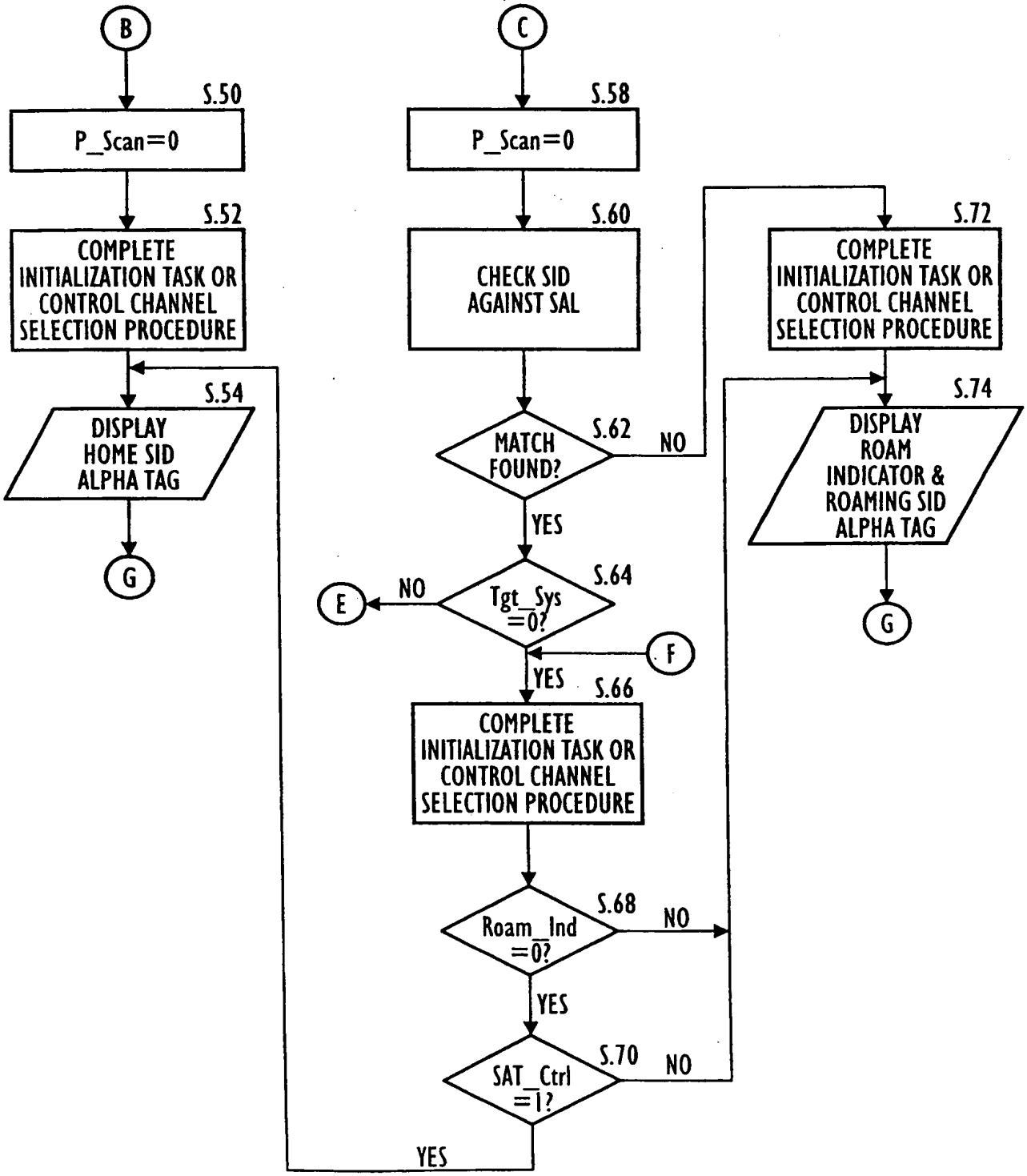

B
S.50
P_Scan=0
S.52
COMPLETE INITIALIZATION TASK OR CONTROL CHANNEL SELECTION PROCEDURE
S.54
DISPLAY HOME SID ALPHA TAG
G
C
S.58
P_Scan=0
S.60
CHECK SID AGAINST SAL
S.62
MATCH FOUND?
NO
YES
S.64
Tgt_Sys =0?
NO
E
F
YES
S.66
COMPLETE INITIALIZATION TASK OR CONTROL CHANNEL SELECTION PROCEDURE
S.68
Roam_Ind =0?
NO
YES
S.70
SAT_Ctrl =1?
NO
YES
S.72
COMPLETE INITIALIZATION TASK OR CONTROL CHANNEL SELECTION PROCEDURE
S.74
DISPLAY ROAM INDICATOR & ROAMING SID ALPHA TAG
G

FIG. 6

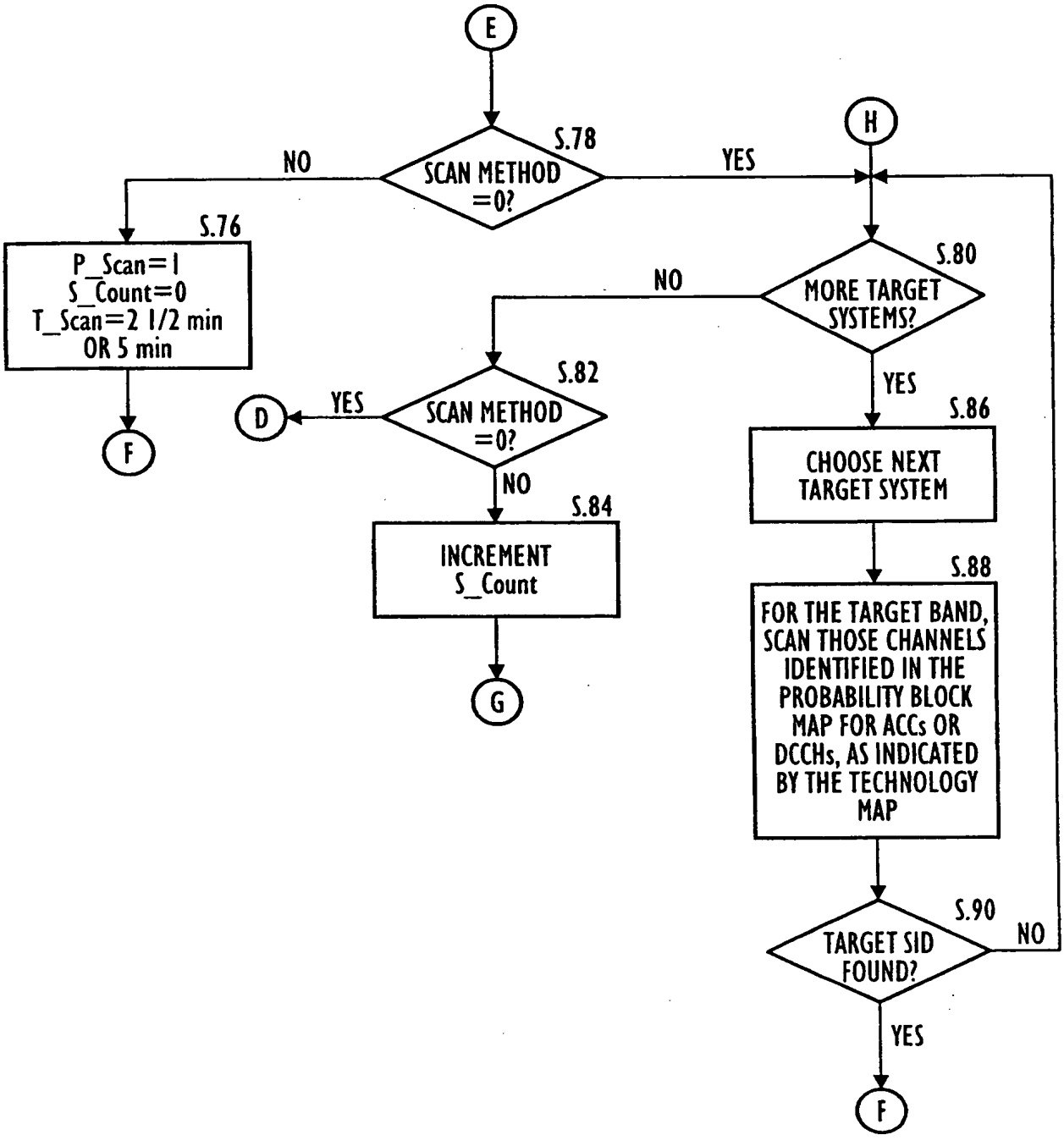

E
S.78
SCAN METHOD =0?
NO
YES
H
S.76
P_Scan=1
S_Count=0
T_Scan=2 1/2 min
OR 5 min
F
S.80
MORE TARGET SYSTEMS?
NO
YES
S.82
SCAN METHOD =0?
YES
D
NO
S.84
INCREMENT S_Count
G
S.86
CHOOSE NEXT TARGET SYSTEM
S.88
FOR THE TARGET BAND, SCAN THOSE CHANNELS IDENTIFIED IN THE PROBABILITY BLOCK MAP FOR ACCs OR DCCHs, AS INDICATED BY THE TECHNOLOGY MAP
S.90
TARGET SID FOUND?
NO
YES
F

FIG. 7

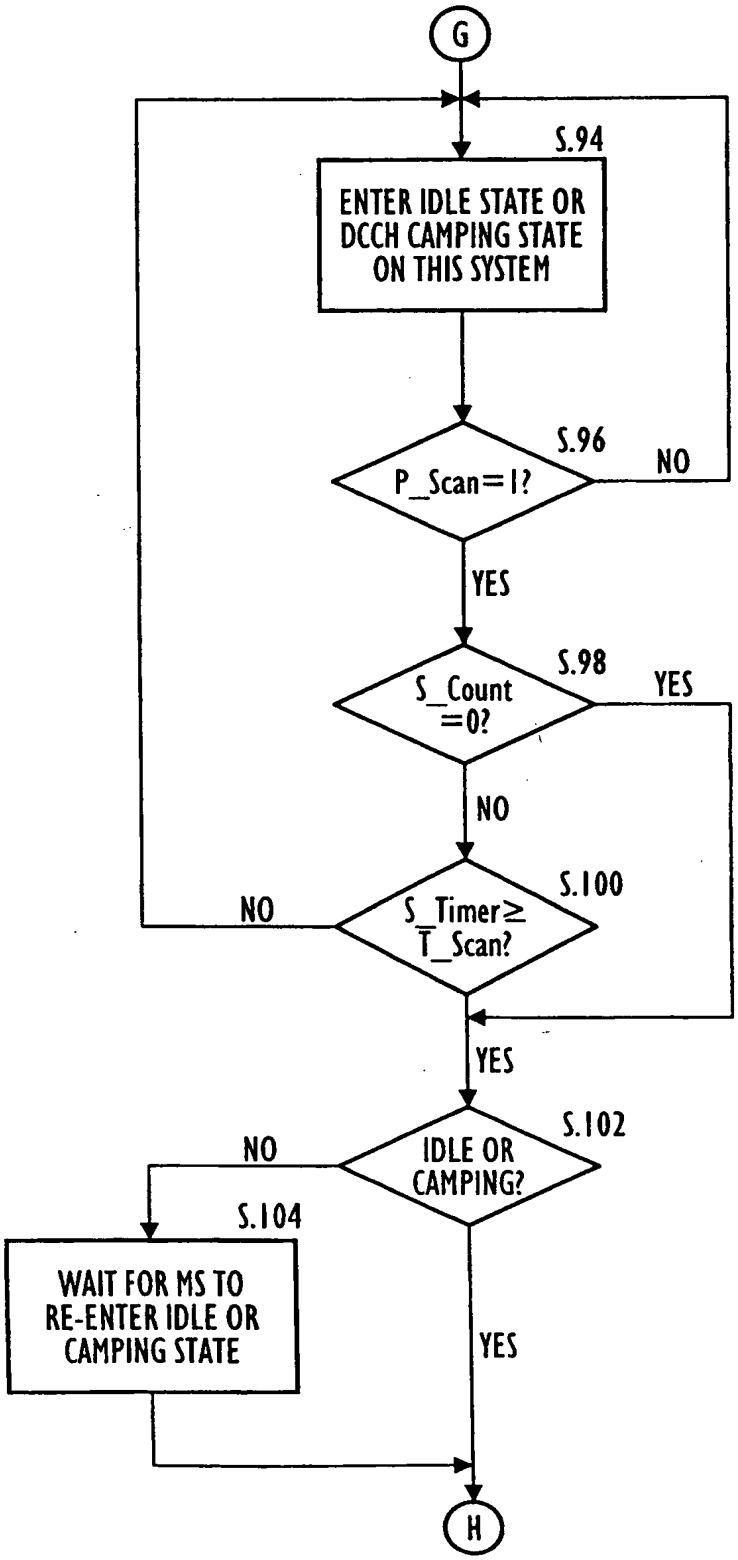

G
S.94
ENTER IDLE STATE OR DCCH CAMPING STATE ON THIS SYSTEM
S.96
P_Scan=1?
NO
YES
S.98
S_Count =0?
YES
NO
S.100
S_Timer≥ T_Scan?
NO
YES
S.102
IDLE OR CAMPING?
NO
S.104
WAIT FOR MS TO RE-ENTER IDLE OR CAMPING STATE
YES
H

FIG. 8

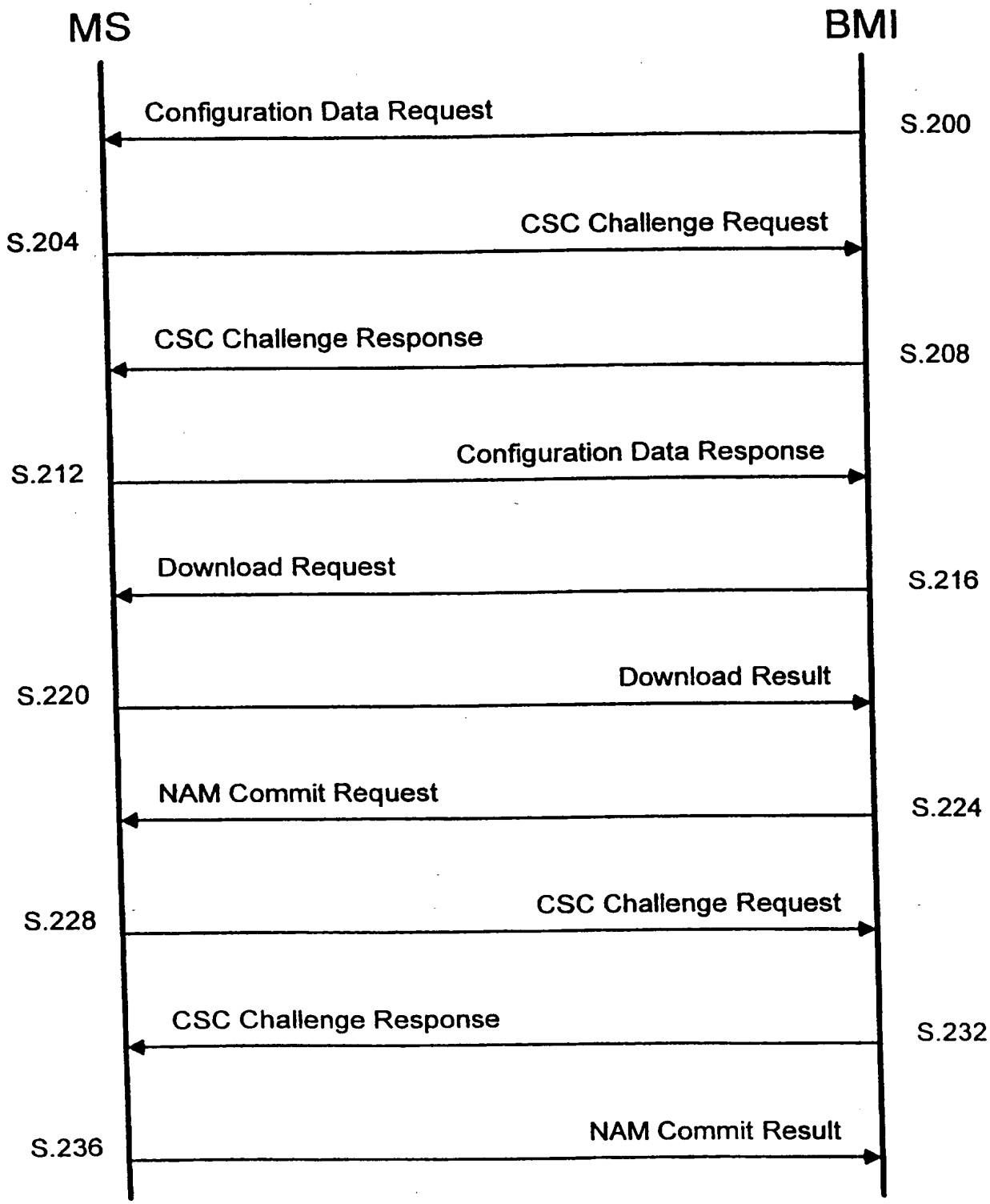

MS
BMI
Configuration Data Request
S.200
CSC Challenge Request
S.204
CSC Challenge Response
S.208
Configuration Data Response
S.212
Download Request
S.216
Download Result
S.220
NAM Commit Request
S.224
CSC Challenge Request
S.228
CSC Challenge Response
S.232
NAM Commit Result
S.236

FIG. 9

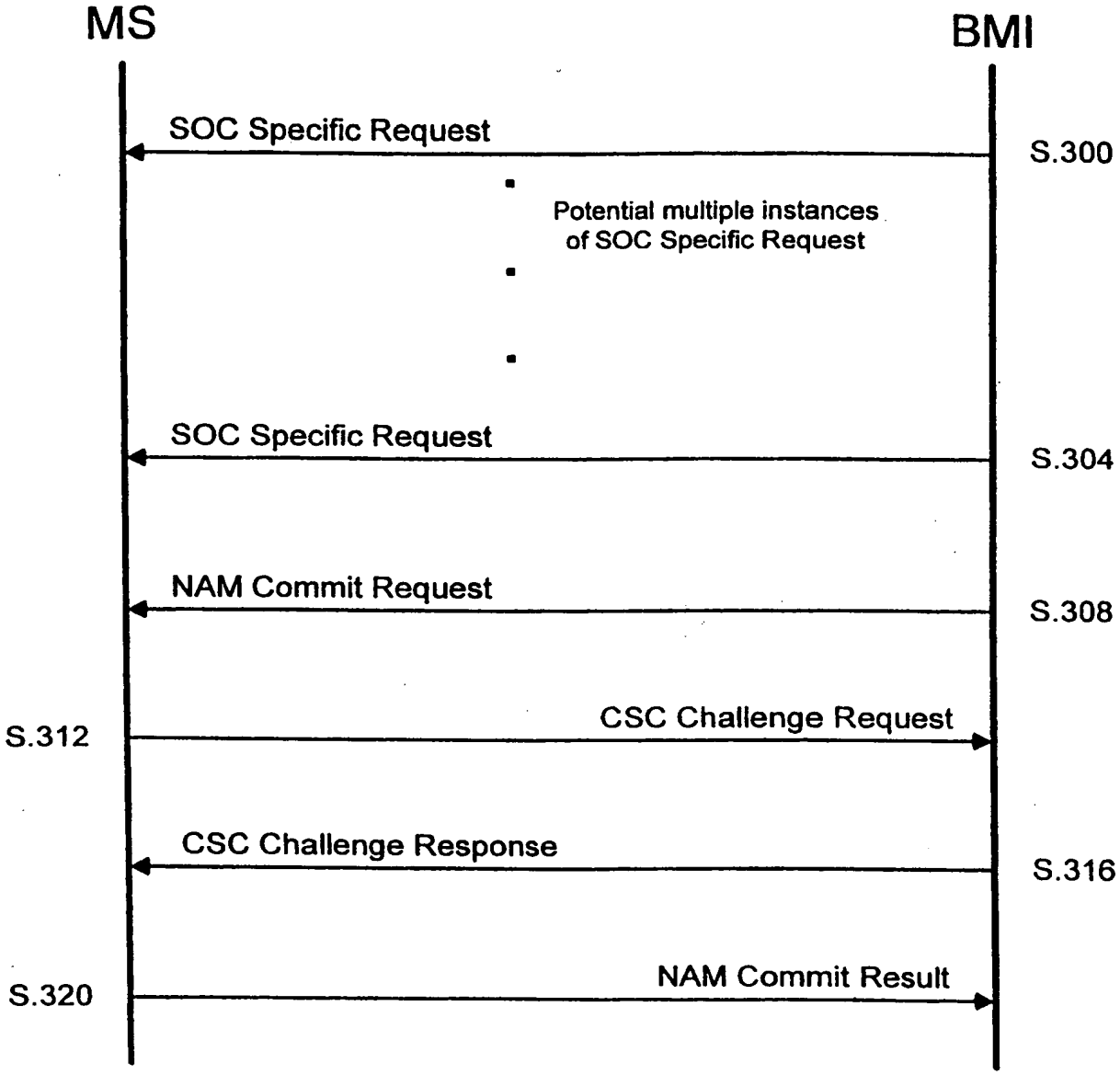
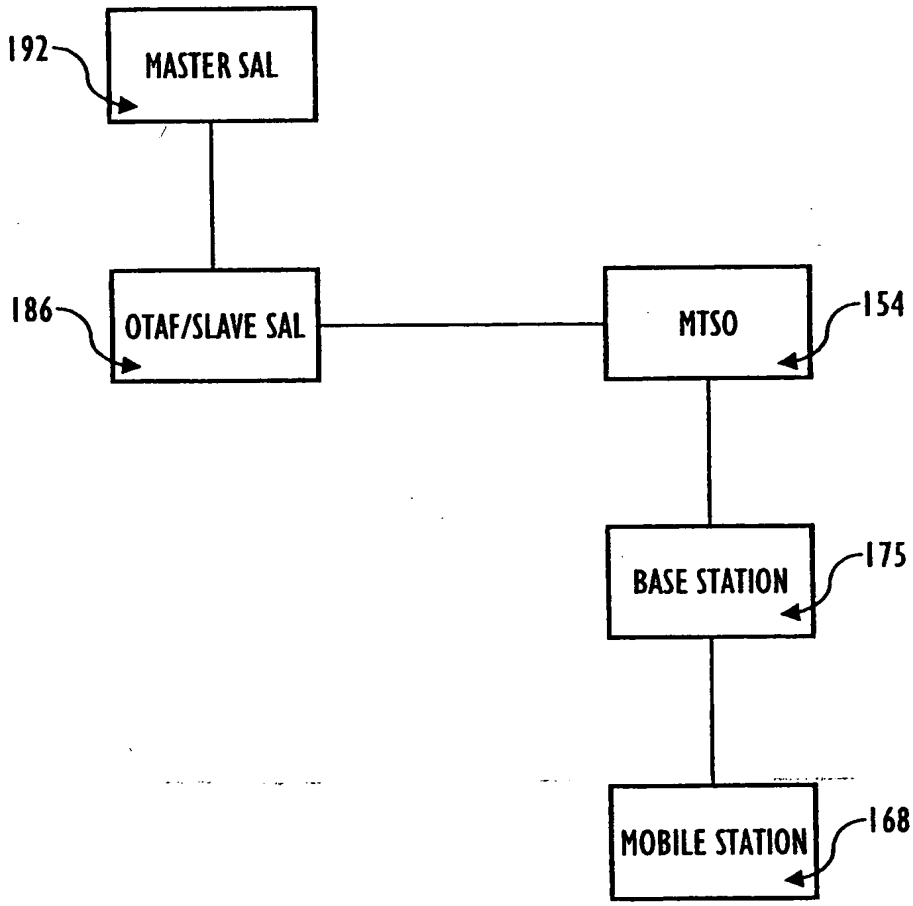

MS
BMI
SOC Specific Request
S.300
Potential multiple instances of SOC Specific Request
SOC Specific Request
S.304
NAM Commit Request
S.308
CSC Challenge Request
S.312
CSC Challenge Response
S.316
NAM Commit Result
S.320

FIG. 10


192
MASTER SAL
186
OTAF/SLAVE SAL
MTSO
154
BASE STATION
175
MOBILE STATION
168

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03805

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04Q 7/22
US CL :455/432

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/432, 433, 434, 435, 461, 550, 551, 552, 403, 422

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Please See Continuation of Second Sheet.	

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

°	Special categories of cited documents:	°T°	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
°A°	document defining the general state of the art which is not considered to be of particular relevance	°X°	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
°B°	earlier document published on or after the international filing date	°Y°	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
°L°	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	°&°	document member of the same patent family
°O°	document referring to an oral disclosure, use, exhibition or other means		
°P°	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 15 JUNE 1998	Date of mailing of the international search report 12 AUG 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer for WILLIAM TROST Telephone No. (703) 308-5318

Form PCT/ISA/210 (second sheet)(July 1992)☆

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03805

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet(1))(July 1992)☆